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THE CONTROL OF THE CHESTNUT BARK DISEASE.

IMPERIAL BUREAU OF MYCOLOGY
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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., August 14, 1911.

Sir: I have the honor to transmit herewith and to recommend for publication as a Farmers' Bulletin a manuscript entitled "The Control of the Chestnut Bark Disease," by Dr. Haven Metcalf, Pathologist in Charge, and Prof. J. Franklin Collins, Forest Pathologist, of the Office of Investigations in Forest Pathology. The writers describe their method of restricting the spread of this dangerous disease by destroying advance infections, a method which is already being applied on a large scale by the State of Pennsylvania. It is hoped to perfect plans whereby through general cooperation the disease may be kept within the territory where infection is already general and the largest and best chestnut forests of the country, especially those of the south Appalachians, be kept permanently free from the disease.

The experimental data upon which the recommendations contained in this publication are based will be published in full in a forthcoming bulletin of the Bureau of Plant Industry.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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THE CONTROL OF THE CHESTNUT BARK DISEASE.

THE DISEASE.

HISTORY AND DISTRIBUTION.

The chestnut bark disease was first recognized as a serious disease in the vicinity of New York City in 1904, and the first publication regarding it appeared in 1906. There is reliable evidence, however, that it was present on Long Island at least as early as 1893. Its origin is unknown, but there is some evidence that it was imported from the Orient with the Japanese chestnut. This view is not, however, held by all investigators. But whatever may have been its time or place of origin, it is certain that it has now spread into at least 10 States, as is shown by the accompanying map (fig. 1). In the vicinity of New York City and through adjacent counties it has killed practically all chestnut trees. Throughout a much larger neighboring area, as shown in figure 1, practically all chestnut trees are infected. Outside of this area, throughout the country from the northern border of Massachusetts and from Saratoga County, N. Y., to the western border of Pennsylvania and the southern border of Virginia, scattering areas of infection are known to occur and may be expected at any point.

So far as is now known, the bark disease is limited to the true chestnuts—that is, to the members of the genus Castanea. The American chestnut, the chinquapin, and the cultivated varieties of the European chestnut are all readily subject to the disease. Only the Japanese and perhaps other east Asian varieties appear to have resistance. In spite of popular reports to the contrary, it can be quite positively stated that the bark disease is not now known to occur on living oaks, horse-chestnuts, beeches, hickories, or the golden-leaf chinquapin (*Castanopsis chrysophylla*) of the Pacific coast.

FINANCIAL LOSSES.

The bark disease appears ultimately to exterminate the chestnut trees in any locality which it infests. A survey of Forest Park (Brooklyn) showed "that 16,695 chestnut trees were killed in the 350 acres of woodland in this park alone. Of this number, about 9,000 were between 8 and 12 inches in diameter, and the remaining 7,000 or more were of larger size." Three years ago the financial loss from this disease "in and about New York City" was estimated at "between five and ten million dollars."

The writers regard $25,000,000 as a conservative estimate of the financial loss from this disease up to 1911. In many localities the greatest damage has been among chestnuts grown for ornamental purposes, which have a value greatly in excess of their value as lumber.

Depression in the value of real estate, especially suburban or near-suburban, owing to the death of the chestnut trees, must be taken into account in an estimate of this kind, as well as the loss of the trees themselves.

CAUSE AND SYMPTOMS.

The chestnut bark disease is caused by a fungus parasite known under the technical name of *Diaporthe parasitica* Murrill. When any of the microscopic spores (reproductive cells) of this fungus gain

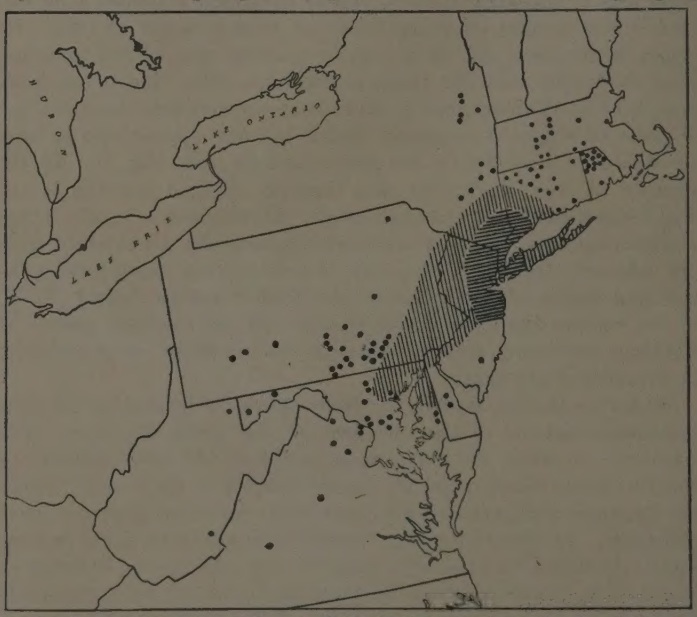

FIG. 1.—Map of the northeastern part of the United States, showing the distribution of the chestnut bark disease. The horizontally lined part shows the approximate area wherein the majority of chestnut trees are already dead from the bark disease. The part marked by vertical lines shows the approximate area wherein infection is already complete. The round dots show the location of advance infections of the disease. Many of these have already been eradicated. The map has been compiled from both observations and correspondence. The writers are under especial obligations to Dr. Perley Spaulding, Prof. A. H. Graves, Mr. I. C. Williams, Mr. W. H. Rankin, Mr. J. F. O'Byrne, Mr. F. W. Besley, Dr. Ernest S. Reynolds, and Mr. H. G. MacMillan, for data along this line. According to Dr. G. P. Clinton (Connecticut Agricultural Experiment Station, Report of the Botanist, 1909 and 1910) there are many more points of infection in Connecticut than are shown on this map.

entrance into any part of the trunk or limbs of a chestnut tree they give rise to a spreading "sore" or lesion, which soon girdles the tree. If the part attacked happens to be the trunk, the whole tree in consequence is killed, perhaps in a single season. If the smaller branches are attacked, only those branches are killed, or only those portions of branches beyond the point of attack, and the remainder of the tree may survive for several years (fig. 2).

Some of the symptoms are quite prominent. Limbs with smooth bark attacked by the fungus soon show dead, somewhat discolored, sunken areas (occasionally with a raised margin), which continue to

FIG. 2.—Large chestnut tree partly killed by the bark disease. Note the sprouts with leaves near the top, the dwarfed leaves on the lower right-hand limb, and the healthy lower branches with leaves.

enlarge and soon become covered more or less thickly with yellow, orange, or reddish-brown spots about the size of a pinhead. These spots are the pustules of the fruiting fungus. In damp weather or in damp situations, masses of summer spores are extruded in the

FIG. 3.—Diseased chestnut bark showing pustules and form of discharge of summer spores in damp weather. (Magnified 3 diameters.)

form of long, irregularly twisted strings or "horns," which are at first bright yellow to greenish yellow or even buff, becoming darker with age (fig. 3). If the lesion is on the trunk or a large limb with very thick bark there is no obvious change in the appearance of the

bark itself, but the pustules show in the cracks and the bark often sounds hollow when tapped. After smooth-barked limbs or trunks are girdled the fungus continues to grow extensively through the bark, sometimes covering the entire surface with reddish-brown pustules (fig. 4). These pustules produce mostly winter spores (ascospores), although occasionally the long strings of summer spores (fig. 3) are also produced, even on bark that has been dead at least a year.

FIG. 4.—Dead chestnut bark showing pustules of the parasitic fungus bearing winter spores.

After a branch or trunk is girdled, the leaves change color and sooner or later wither. Such branches have a very characteristic appearance and can hardly be mistaken for anything else, except in certain localities where the work of twig-girdling insects may produce a similar appearance in the spring. In case the girdling by the fungus is completed late in the season, the leaves of the following spring assume a yellowish or pale appearance and do not develop to their full size (fig. 2). If the girdling is completed between spring and midsummer the leaves may attain their full size and then turn

a somewhat characteristic reddish-brown color, which can easily be detected at a long distance. Later this leaf coloration changes to a more brownish tinge and the leaves are commonly persistent for a considerable time. The chestnut fruits (burs) on a spring-girdled branch may or may not attain full size, according to whether the girdling by the disease was completed late or early in the spring. These burs commonly persist on the tree during the following winter, thus producing the only symptom which is at all conspicuous during the leafless season. The great damage which the disease has done in the late summer thus becomes most evident at the beginning of the next season, and that done in the spring becomes evident later in the same season, giving rise to the false but common idea that the fungus does its work at the time of year that the leaves change color, when in reality the harm was done much earlier.

Perhaps the most easily seen as well as the longest persistent symptom of the bark disease is the prompt development of sprouts, or "suckers," on the trunk of the tree (fig. 2) and at its base, or somewhat less frequently on the smaller branches. Sprouts may appear below every girdling lesion on a tree, and there are usually many such lesions. These sprouts are usually very luxuriant and quick growing, but rarely survive the second or third year, as they in turn are killed by the fungus. The age of the oldest living sprout, as determined by the number of its annual rings, is an indication of the minimum age of that portion of the infection immediately above it. Sprouts are sometimes produced as a result of other injuries; for instance, trees girdled by borers may develop sprouts, but these are generally less rapid in growth and are distributed with greater uniformity over the trunk.

MEANS OF SPREAD AND ENTRANCE.

The disease is spread by the spores of the fungus, of which there are two kinds. As both kinds of spores appear to be sticky, there is no evidence that they are transmitted by wind except where they may be washed down into the dust and so blown about with the dust. The spores are spread easily through short distances by rain; particularly they are washed down from twig infections to the lower parts of the tree. There is strong evidence that the spores are spread extensively by birds, especially woodpeckers, and there is also excellent evidence that they are spread by insects and by various rodents, such as squirrels. The disease is carried bodily for considerable distances in tan bark and unbarked timber derived from diseased trees. One of the most prolific sources of general infection has been the transportation of diseased chestnut nursery stock from infected to uninfected localities.

When the spores have once been carried to a healthy tree, they may develop in any sort of hole in the bark which is reasonably moist. These may be wounds or mechanical injuries, but by far the most common place of infection is a tunnel made by a borer. Borers' tunnels are moist, even in dry weather, and in them the spore finds surroundings favorable to its development. In many parts of the country where the disease is prevalent there is very direct evidence that bark borers, and particularly the two-lined chestnut borer (*Agrilus bilineatus*), are directly associated in this way with 90 per cent or more of all cases of this disease. We are informed that the Bureau of Entomology will issue a circular on the insects associated with the chestnut bark disease.

The writers have no definite evidence, experimental or otherwise, to show that a tree with reduced vitality is more susceptible to infection, or that the disease spreads more rapidly in such a tree, than in a perfectly healthy and well-nourished tree of either seedling or coppice growth, provided that such reduced vitality does not result in or is not accompanied by bark injuries through which spores can gain entrance.

THE CONTROL OF THE DISEASE.

ELIMINATION AND QUARANTINE.

FUNDAMENTAL OBSERVATIONS AND EXPERIMENTS.

No method of immunizing individual trees against the bark disease is yet known, and no method of treating or curing them when once attacked is certain in its results. While this is unfortunate from the standpoint of the owner of orchard trees and large ornamental trees of great individual value, no method of dealing with single trees—surgery, medication, spraying, etc.—however successful in itself, would meet the demands of the present situation. It is not practicable at present to apply any individual method of treatment to forest trees; the individual tree is not worth it, and will not be for many years. Therefore, so far as the chestnut forests are concerned we do not need to regret particularly that no individual treatment has yet been discovered that is entirely effective.

Fortunately, however, there is a method of dealing with the situation which is applicable to the country as a whole and which, so far as tested, is practicable. Early in the course of the writers' investigations it became evident that the disease advances but slowly in a solid line, but instead spreads from isolated centers of infection, often many miles in advance of the main line of disease. That such is the case is evident from a glance at figure 1. It therefore seemed probable that if these advance infections could be located at a reasonably early stage, they could be eliminated at relatively little expense, thus preventing further spread from these

points at least. Accordingly, the country within approximately 35 miles of Washington, D. C., was chosen in the fall of 1908 as preliminary territory in which to test this method of control. This section has since been gone over fairly thoroughly once a year. As will be seen by figure 1, 14 points of infection were located, and the infected trees destroyed. Most of this work was done by the senior writer. The largest infection was a group of nursery trees that had been imported from New Jersey; the smallest, a single lesion on a small branch of a large forest tree. In one case 11 forest trees in a group were infected, the original infection having been two trees, dating apparently from as early as 1907. Up to the present time (June, 1911) the disease has not reappeared at any point where eliminated and the country within a radius of approximately 35 miles from Washington is apparently free from the bark disease, although new infections must be looked for as long as the disease remains elsewhere unchecked. It is therefore believed that this method of attack will prove equally practicable in other localities, and if carried out on a large scale will result ultimately in the control of the bark disease.

LEGAL CONSIDERATIONS.

In carrying such a scheme of control into effect on a large scale, however, legal difficulties are at once encountered. The bark disease threatens the extinction of the chestnut throughout its range. As it has already been found in at least 10 States and the District of Columbia, it is essentially a national issue, but there is no law whereby the Federal Government can attempt to cope with the emergency. Each State must act on its own initiative and control the disease or let it go as its officers and legislative bodies see fit. Herein lies one of the most serious aspects of the matter; for if one State elects to undertake control of the disease it will be seriously handicapped if neighboring States do not. Any method of elimination, isolation, or quarantine in dealing with any disease of plants, domestic animals, or human beings necessitates general cooperation. It is not practicable to try to control the bark disease solely by the cooperation of individual owners of chestnut woodland, since a single indifferent or obstinate person can nullify the efforts of an entire community. The control of the chestnut bark disease must therefore be undertaken by the separate States under special legislation. Possibly in certain States the crop and woodland pest laws, which ordinarily apply only to nursery stock, may be broad enough to include this disease, but in most States the first thing to be done is to obtain the necessary legal authority and an appropriation for action along the following lines, as has already been done in Pennsylvania.

THE METHOD IN DETAIL.

Locating advance infections ("scouting").—The first thing to be done in each State is to determine the exact range of the disease in that State, and particularly to locate the advance points of infection. This is by far the most difficult feature of the entire program, because the work must be directed and in large measure carried out by experts; otherwise diseased trees will be left, and the results can not be depended upon. It is best intrusted to professional plant pathologists or at least to botanists familiar with fungi and the collecting of fungi, and even these must have some preliminary knowledge of this particular disease. The symptoms of the disease are too obscure and the means of locating it too intricate to make it possible for a person without a professional knowledge of plant diseases to deal successfully with the situation, no matter how well informed in agriculture or forestry or how experienced in the care of trees. It is suggested that in most States this part of the work would be best handled by the pathologists of the State agricultural experiment stations.

For assistants the pathologists having this work in charge should choose the best scientific observers obtainable, regardless of other considerations, but persons with some knowledge of plant pathology are to be preferred. College students trained in these lines are usually available, for the summer vacation at least, and make in many respects the most desirable "scouts" for this work. But all "scouts" must be carefully and individually trained by the expert in charge.

Attention should first be directed to the advance spots of infection already known to exist, and when found the diseased trees should be destroyed or marked for destruction. No difficulty will be experienced in locating infections 2 years old or more, but the greatest difficulty will be met in locating infections of the current year. Every tree in the immediate vicinity of older infected trees must be carefully gone over. Many dubious cases will be found, and from such trees samples of the suspected bark must be taken and sent to some laboratory for expert judgment. It is absolutely necessary to have arrangements with some laboratory whereby such work can be done and the results promptly reported.

After the spots already known to exist have been delimited and the trees destroyed or marked for destruction, the search should be continued. It is best next to clearly define the location of the main line of advance of the disease, back of which infection is general. Working away from this line as a base, a complete survey of the remainder of the State must be made, until it is reasonably certain that all spots have been located.

Scouting is best discontinued as soon as the leaves change color in the fall, since from October to April, inclusive, the symptoms are

very obscure. Practically no sign of the disease is visible from a distance, except in those cases where the burs persist on the older trees. Even the pustules of the fungus become weathered, so that even a close examination of a tree may not yield visible results. But the destruction of trees already marked can continue through the winter.

Destroying advance infections.—Many of the advance infections will be found to consist of single trees or of less than half a dozen trees. These may perhaps be destroyed by the person who finds them, especially if remote from other infections; but the greater part of the work of elimination is best handled by other persons under separate direction. Undoubtedly this work can be best directed in each State by the State forestry officials.

The work of elimination should be done as soon as possible after the diseased trees are located, but may be done at whatever time of year is most convenient, since new infections will be detected by the scouting of the following year. The marked trees should be cut down. So far as is now known, the timber may be safely utilized in various ways, *provided it is barked*. The bark and brush should be piled over the stumps and, as soon as practicable, burned. If it is not practicable to have the fire over the stumps, the stumps should be barked to the ground; but in any case the bark and brush must be burned.

It will be readily seen that the task of locating the disease, and the subsequent one of eliminating it, call for very different talents. The "scouting" calls for carefully trained and absolutely accurate scientific observers working under the most highly specialized direction that can be obtained. The work of elimination calls not for scientific knowledge, but for executive ability, tact in dealing with owners and in otherwise administering the law, and a knowledge of forestry and of lumbering, market, and transportation conditions. In a word, the first is a task for pathologists, the second for foresters. Another advantage of thus dividing the work is that a certain rivalry will usually develop, resulting in more thorough work on both sides. It is, moreover, of the utmost importance to have as many different forces and interests as possible in any given State working toward the common end of controlling this disease.

Establishing the "immune zone."—After all advance spots of infection are eliminated, attention must be turned to the main line of advance—the edge of the area of general infection. Here the problem will present local differences. It may prove necessary in some States to destroy all chestnut trees, diseased or healthy, in a belt 10 to 20 miles wide, or possibly less. Advantage must be taken of natural barriers to infection, such as unforested areas or wooded areas without chestnuts. In this way an "immune zone" will be established, across which the disease can not easily be transmitted by

merely local agents. Back of this line the chestnut trees may be abandoned to the disease. Every effort should be made, however, to have them cut down and the timber utilized as soon as possible, since they remain sources of distant infection as long as any spore-laden bark or diseased sprouts remain on them.

Quarantine.—Whether any restrictions are placed upon the movement of chestnut products from the area of complete infection to the protected territory will depend largely on local conditions and must be left to the judgment of State authorities. Barked timber can probably be moved with comparative safety. It will always be desirable to limit the movement of unbarked chestnut timber and firewood and of chestnut tan bark. An inspection of local conditions will readily determine whether the danger from these sources is sufficiently great to warrant the business inconvenience which would be caused by the quarantine of any or all chestnut products.

Program for the second year.—The work for the second year will consist mostly of reinspection of the advance spots where the bark disease has been eradicated the previous year and of general scouting to locate new spots. If the work of the first year has been thoroughly done and there has been time to complete the elimination of all spots located, only scattering infections may be expected. From this time on the persons in charge of scouting will have the bulk of work and responsibility.

THE EXAMPLE OF PENNSYLVANIA.

Pennsylvania enjoys the distinction of being the first and so far the only State to undertake in any way the control of the chestnut bark disease. In the summer of 1910 the Main Line Citizens' Association—an organization of citizens residing along the main line of the Pennsylvania Railroad near Philadelphia—appointed a committee of seven, under the chairmanship of Mr. Harold Peirce, to determine the status of the disease in that locality and to see what could be done toward controlling it. An extensive local survey of the disease was made under the direction of Mr. I. C. Williams, deputy State forest commissioner. The committee soon became convinced that the problem was of State and even national importance, and could only be solved by legislation and by the broadest cooperation. Accordingly they devoted their energies to securing the passage by the Pennsylvania Legislature of the following bill, which has now become a law. This law is almost unique in conservational legislation, and on account of its important bearing as precedent for similar laws in other States it is here reproduced in full.

AN ACT To provide efficient and practical means for the prevention, control, and eradication of a disease affecting chestnut trees, commonly called the chestnut-tree blight; providing for the destruction of trees so affected; creating a commission to carry out the purpose of this act; fixing penalties for violation of the provisions hereof; and making an appropriation therefor.

SECTION 1. *Be it enacted by the Senate and House of Representatives of the Commonwealth of Pennsylvania in General Assembly met; and it is hereby*

enacted by the authority of the same: That a commission to consist of five members, to be appointed by the Governor for a period of three years from the date of the approval of this act, and to be called "The Commission for the Investigation and Control of the Chestnut-Tree Blight Disease in Pennsylvania," is hereby created, with power to ascertain, determine upon, and adopt the most efficient and practical means for the prevention, control, and eradication of a disease of the chestnut tree commonly known as the chestnut-tree blight disease; and for this purpose, in collaboration with the department of forestry, or otherwise, to conduct scientific investigations into the nature and causes of such disease and the means of preventing its introducton, continuance, and spread; to establish, regulate, maintain, and enforce quarantine against the introduction and spread of such disease; and, from time to time, to adopt and prescribe such regulations and methods of procedure as to it may seem necessary and proper for carrying into effect the purpose of this act, and exercising the powers and authority hereby conferred: *Provided*, That in the work of collaboration by the commission with the Department of Forestry said department may employ such means, and make detail of such men, and do such other things, as may seem to be necessary or expedient to accomplish the purpose of this act.

SEC. 2. Any member of the commission, or any of its duly authorized agents or employees, shall have the right, at any time, to enter upon any premises, wild lands, farms, fields, private grounds, and inclosures for the purpose of examining into the condition of any chestnut tree or trees thereon, and determining whether or not such trees, or any of them, have been attacked or infected by the chestnut-tree blight; and whenever this disease is found to exist, such commissioners, their duly authorized agents and employees, shall, in all practicable ways, cooperate with the owners of such trees in and for the removal, cure, control, and eradication of such disease, and the prevention of its spread to other chestnut trees upon adjoining and other properties; shall specifically advise and direct such owner how he shall proceed for the accomplishment of these ends; and shall leave with such owner, his agent, tenant, or other representative having charge of such trees, a notice, in writing, containing a description or plan specifically designating the trees so found to be diseased, and full and specific instructions for the treatment of such trees, or for the removal and destruction of designated parts thereof or of an entire tree or trees, as the case may require.

SEC. 3. If any owner of such trees, so found to be diseased by the said commission, its duly authorized agents or employees, shall neglect or refuse to cooperate in applying the necessary remedies for the removal, cure, control, and eradication of such disease, and the prevention of its spread to other chestnut trees upon adjoining and other properties; or shall neglect or refuse to comply with the requirements of the notice aforesaid, prescribing the treatment which shall be applied to such trees, so found to be diseased, within twenty days from the time such notice shall have been served, the said commission may at once proceed, through its duly authorized agents and employees, to do whatever may be found by it to be necessary and proper to accomplish the cure, control, or eradication of such disease and the prevention of its spread to other chestnut trees; and for this purpose, whenever it may be found necessary may remove, cut down, and destroy, or cause to be removed, cut down, or destroyed, any trees or parts of trees so found to be infected with such disease; and shall immediately thereafter duly certify to the owner of such trees, so treated or destroyed, or to his tenant, agent, or other representative in charge of such trees, the amount of the cost or expenses actually incurred by the commission in the treatment, removal, or destruction of such trees; and

if the amount of such expense, so certified, shall not be paid by such owner of said trees, so treated, removed, or destroyed within sixty days after it shall have been so certified, the same may be recovered by the said commission, from such owner, by an action in the name of the Commonwealth, in the same manner as debts of like amount are now recoverable, and when recovered may be used by said commission in carrying out the purposes of this act.

Provided, however, That any owner or owners of trees, his or their tenants, agents, or representatives, who may be dissatisfied with any decision, order, or notice of any member of the commission, or any of its agents or employees, directing or prescribing the treatment, removal, or destruction of trees belonging to or controlled by them, shall have the right within ten days from the time of the service upon them of such order or notice to appeal therefrom, in writing, to the commission, which shall thereupon, without avoidable delay, direct a re-examination of the premises or trees in question, by competent experts, who shall make report of their findings to the commision; which shall then fix a time and a place for a hearing before it, upon such appeal, and notify the person making appeal thereof. All further proceedings under such order or notice shall be suspended until the decision of the commission shall have been formally rendered.

SEC. 4. Whenever, in the judgment of the commission, it may be necessary to destroy chestnut trees not affected by the chestnut-tree blight, for the purpose of establishing a quarantine to prevent and control the spread of the disease, the owner of such trees shall be reimbursed for the loss of all the good and unaffected trees so destroyed; the amount to be paid therefor to be not greater than the stumpage prices of such trees, prevailing at the time in the locality where such trees grew; such value to be determined by the commission, by such method or procedure as it may adopt, and payment therefor to be made from the fund hereinafter specifically appropriated for the use of the said commission in performing the duties required by this act. Should any owner of trees be dissatisfied with the amount awarded to pay for the destruction of such good and unaffected trees, said owner shall have all the remedies now existing, or which may hereafter be provided by law, for the protection of his interests.

SEC. 5. Any person who shall wilfully violate any of the provisions of this act, or any of the regulations of the commission intended to assist in carrying this act into effect, or shall wilfully resist or interfere with any agent or employee of the said commission in the performance of his duties in accordance with the regulations and orders of the commission, under the provisions hereof, shall be deemed guilty of misdemeanor, and shall upon conviction thereof be punished by a fine not exceeding one hundred dollars, or by imprisonment not exceeding one month, either or both, at the discretion of the court. The word "person," as used in this act, shall include not only individuals or natural persons, but as well artificial persons, existing only in contemplation of law, and shall be construed to mean partnerships, limited partnerships, joint-stock companies, and corporations, and the officers, agents, and employees of the same.

SEC. 6. The members of the commission shall serve without pay, but shall be reimbursed for all actual expense incurred by them in exercising the powers conferred upon them and performing the duties required by this act. The employees of the commission shall receive such compensation for their services as the commission shall determine will fairly compensate them for the work to be done. The commission shall be furnished with suitable rooms in the Capitol building at Harrisburg, or elsewhere, by the Superintendent of Public Grounds and Buildings. The sum of twenty-five thousand dollars is hereby specifically appropriated, to be immediately available upon the approval of this

act, for the payment of such expense as may be incurred by the commission, for such scientific research and for office expenses, as in their judgment may be necessary to comply with the provisions hereof, said appropriation to be available until the first day of June, Anno Domini, one thousand nine hundred and thirteen; and the further sum of two hundred and fifty thousand dollars, or so much thereof as shall be necessary, is hereby specifically appropriated, to be available only upon the approval of the Governor, for the performance of all other duties herein required to be done; as, for quarantine, removal of diseased trees or other trees, conducting outside investigations and operations, and every other means of eradication and control, as to it may seem necessary in complying with the provisions hereof.

SEC. 7. All acts or parts of acts inconsistent herewith are hereby repealed.

The commission authorized by the bill has been appointed by the governor of Pennsylvania and consists of the following persons: Mr. Winthrop Sargent, chairman; Mr. Harold Peirce, secretary; Messrs. Samuel T. Bodine, George F. Craig, and Theodore N. Ely. Persons desiring information regarding the work on this disease in Pennsylvania should address the executive officer of the commission, Mr. Samuel B. Detweiler, 1112 Morris Building, Philadelphia, Pa.

INSPECTION OF DISEASED NURSERY STOCK.

As has been indicated, diseased chestnut nursery stock has in the past been a most important factor in the spread of the bark disease. On account of a well-grounded fear of this disease much less nursery stock is being moved now than formerly, but there is still enough to constitute a serious source of danger. It is therefore obvious that every State in which the chestnut grows, either naturally or under cultivation, should as speedily as possible pass a law putting the chestnut bark disease on the same footing as other pernicious diseases and insect pests, such as peach yellows and the San Jose scale, against which quarantine measures are taken. Many inspectors already have legal power to quarantine against the bark disease on chestnut nursery stock, and they should now take special care that no shipment, however small, escapes their rigid inspection.

The most serious practical difficulty in inspecting nursery stock for this as for other fungous diseases lies in the fact that practically all State inspectors are necessarily entomologists, and are not trained in recognizing the more obscure symptoms of fungous diseases. Nursery trees affected by the bark disease rarely show it prominently at the time when shipped; the threads of summer spores or the yellow or orange pustules are rarely present, and usually all the inspector can find is a small, slightly depressed, dark-colored area of dead bark, usually near the ground, which is easily overlooked or mistaken for some insignificant injury. Upon cutting into such a spot, the inner bark shows a most characteristic disorganized "punky" appearance, quite different from that of any other bark injury; but it is impossible to adequately describe this appearance without recourse to colored illustrations. Occasionally a yellowish-brown band, either

girdling or partly girdling the young tree, may be seen; this is very characteristic, but is so prominent a symptom that it may be noticed at the nursery, and presumably trees so affected will not be shipped.

If infected trees are set out they develop the disease with its characteristic symptoms the following spring. But on account of their small size such trees are girdled and die before the end of the summer, often in two or three weeks. Meanwhile they are spreading the disease to neighboring orchard and forest trees. Orchardists and nurserymen purchasing chestnut trees are therefore warned to watch them closely during the first season, no matter how rigidly they may have been inspected.

INDIVIDUAL TREATMENT OF DISEASED TREES.

Where valuable ornamental, shade, or orchard chestnut trees become infected in one or more spots, the life and usefulness of such trees can be prolonged for several or for many years, depending largely upon the thoroughness with which the recommendations herein given for cutting out the diseased areas (lesions) are carried out. These recommendations are based upon the results of extensive experiments with hundreds of lesions during the past four years. These experiments were performed for the most part by the junior writer.

The essentials for the work are a gouge, a mallet, a pruning knife, a pot of coal tar, and a paint brush. In the case of a tall tree a ladder or rope, or both, may be necessary, but under no circumstances should tree climbers be used, as they cause wounds which are very favorable places for infection. Sometimes an ax, a saw, and a long-handled tree pruner are convenient auxiliary instruments, though practically all the cutting recommended can be done with a gouge with a cutting edge of 1 or 1½ inches. All cutting instruments should be kept very sharp, so that a clean and smooth cut may be made at all times.

By cutting with the gouge into a diseased area a characteristically discolored and mottled middle and inner bark is revealed. All of this diseased bark should be carefully cut out for at least an inch beyond the discolored area if the size of the branch will allow it. This bark should be collected in a bag or basket and burned. If the cutting is likely to result in the removal of the bark for much more than half the circumference of the branch or trunk, it will probably be better to cut off the entire limb or to cut down the tree, as the case may be, unless there is some special reason for attempting to save the limb or tree. The fungus usually, though not always, develops most vigorously in the inner bark next to the wood. When this is the case, not only all the diseased bark and an inch of healthy bark around it must be removed, but at least two or three annual layers of wood beneath the diseased bark must also be gouged out. Special care should be taken to avoid loosening the healthy bark at

the edges of the cut-out areas. Except in the early spring this is not difficult after a little experience in manipulating the gouge and mallet, provided the gouge is kept sharp.

Small branches which have become infected should be cut off, the cut being made well back of the disease—at least 2 or 3 inches, if possible.

All cut-out areas and all the cut ends of stubs should be carefully and completely painted with coal tar. A good grade of paint has been recommended by some authorities as superior to tar, but it is more expensive. If the tar is very thick, the addition of a little creosote will improve it for antiseptic purposes as well as for ease in applying. If the first coat is thin, a second one of fairly thick tar should be applied within a few weeks or months. Other coats should be applied later whenever it becomes necessary.

The entire tree should be carefully examined for diseased spots and every one thoroughly cut out and treated in the way already described. In case of suspicious looking spots a portion of the outer bark can be cut out with the sharp gouge as a test. If this cut shows the characteristically discolored bark the spot can be considered as diseased and cut out accordingly; if the cut shows healthy bark, it need merely be treated with tar or paint, as other cuts are treated. In examining a tree for diseased spots it is always best to begin at the base of the trunk and work up, for if the trunk is girdled at the base it is useless to work anywhere on the tree.

When the spores of the fungus are present, especially in the form of threads, or "horns," they are readily washed down the branches and trunk by every rain, and are thus carried down to or toward the base of the tree. As a result the base of a tree, the crotches, and other places which afford easy lodgment for the spores are particularly subject to infection.

Although spraying with any of the standard fungicides appears to have no effect whatever in stopping the progress of the disease after it has once started in the inner or middle bark, there is little doubt that it is of use in preventing infection from spores washed down by rain from the upper part of a tree or from spores which have been transported from other trees. For this reason the spraying, after each rain, of the parts of a tree below a spore-bearing lesion is recommended, but only on an experimental basis. If no spore-bearing lesions occur on the tree, there is less apparent reason for spraying. The scattering of slaked lime about the base of a tree and the whitewashing of the trunk and larger limbs have shown apparently beneficial results in preventing infections and perhaps also depredations of borers.

A tree which is being treated for individual infections must be carefully watched and the diseased spots promptly cut out as they appear. For this purpose each tree should be examined very carefully two or three times at least during the growing season.

The Department of Agriculture asks the cooperation of all persons who have experimented with the disease in any way, and in return is ready to give specific advice, based upon extensive experience with the disease, as to the best methods of attempting its control or as to what are likely to be the most profitable systematic observations or experiments.

ADVICE TO CHESTNUT ORCHARDISTS.

In view of the uncertain future of the chestnut tree, the Department of Agriculture advises against planting chestnuts anywhere east of Ohio, at least until it is settled what efforts will be made by the individual States to control the bark disease. The only exception is that Japanese chestnuts may be grown if raised from imported seeds and not grafted on American stocks. If the seed is raised in America, the trees are more than likely to be hybrids with the American chestnut and to vary greatly in resistance to the bark disease. If grafted on American stocks, the stocks readily succumb to the disease, and so the whole tree is killed, no matter how resistant the scion may be. However, the nut of the true Japanese chestnut is of poor quality at best, and it is an open question whether it can ever be made a commercial success.

West of the natural range of the American chestnut, however, the situation is quite different. Obviously the western chestnut orchardist has before him a great opportunity. No matter how successful efforts to limit the bark disease in the East may be, the nut crop will be reduced for some years, and the business of growing fine orchard chestnuts in the East will be depressed for the same length of time. There is no apparent reason why, with rigid inspection, both of any purchased stock and of the orchards themselves, all chestnut orchards and nurseries from Ohio to the Pacific coast can not be kept permanently free from the bark disease; therefore all persons interested in growing the chestnut in the West as an orchard tree are earnestly advised not to secure any chestnut nursery stock from eastern nurseries; to be sure that stock from any source is rigidly inspected; to watch with the utmost care their own nurseries and orchards; and to destroy immediately by fire any trees that may be found diseased.

There is presumptive evidence that the bark disease was introduced into America on the Japanese chestnut, but until this point is definitely settled orchardists west of Ohio are advised not to import nursery stock of this variety. Seed can probably be imported with a reasonable degree of safety, however.

ADVICE TO OWNERS OF CHESTNUT WOODLAND.

Owners of chestnut woodland anywhere within the area of complete infection are earnestly advised to convert their trees into lumber as quickly as possible. The trees that are not already killed will soon die in any case and the timber will quickly deteriorate in quality. Such

trees are a continual source of further infection, and, moreover, large areas of dead chestnut trees, by harboring bark and wood inhabiting insects, are likely to start some insect epidemic. Indeed, with the quantity of dead chestnut timber now standing it will be remarkable if some serious infestation of insects extending to sound trees does not follow.

Owners of chestnut woodland outside the area of general infection are counseled to watch for the first appearance of the disease, and when it appears to cut down immediately all affected trees, bark them, and burn the bark and brush, over the stump if practicable. Such procedure will distinctly retard the spread of the disease in that particular woodland, even if no concerted efforts at elimination are made by neighboring owners. It is to be expected, however, that in all cases of this kind the owner will have the cooperation of the State authorities in a general quarantine movement.

It is almost needless to add that until we know what action is to be taken in all the chestnut-growing States and what the results are likely to be, chestnut woodland is a poor investment. Furthermore, in forest management, as in improvement cuttings, etc., there should be discrimination against the chestnut.

ADVICE TO OWNERS OF ORNAMENTAL CHESTNUT TREES.

Until the future of the chestnut tree is better known, or at least until we know what legalized action is going to be taken in the States concerned, the owners of chestnut-timbered land available for building should pursue a very conservative policy. Houses should not be located with sole reference to chestnut groves or to isolated ornamental chestnut trees. Houses so located should be discriminated against in purchasing homes in so far as the death of the chestnut trees would injure the appearance of the place.

When ornamental trees become diseased they had better be cut down at once and, if practicable, large trees of other species moved in to take their places. In expert hands the moving of large trees is a perfectly practicable and successful procedure and, although more expensive, is much more satisfactory than waiting for nursery trees to grow.[1]

All owners of diseased ornamental chestnut trees are specifically warned against "fake" tree doctors. Large sums of money have been paid out in many cases for treatment that has been worse than useless. Reliable tree specialists will have nothing to do with trees affected with the chestnut bark disease, or, if they do anything, do it with the distinct understanding in advance that it is entirely at the

[1] In case such action is not immediately desirable or possible, a very good, though temporary, scenic effect can be obtained by lopping off the ends of the larger branches of the dead and dying chestnut trees, removing the bark, and planting some rapid-growing vine at their foot, which soon covers them. One of the best for this purpose is the Japanese kudzu vine (*Pueraria thunbergiana* (S. and Z.) (Benth.), on account of its extraordinarily rapid growth. Such vine-covered stumps must be carefully watched, however, for in a very few years they decay and are liable to be blown over.

owner's risk. Of course, if an owner desires to employ tree surgeons to experiment, that is another matter.

ADVANCING POPULAR KNOWLEDGE OF THE DISEASE.

In the localities where infection is general or complete (fig. 1) everyone knows what the chestnut bark disease is and what its symptoms are and everyone appreciates its seriousness; but in these localities it is too late even to attempt its control. On the other hand, in Delaware, Virginia, West Virginia, western and southern Maryland, western Pennsylvania, central and northern New York, Massachusetts, and Rhode Island very few people know the symptoms of the disease. On this account no one notices it until it is thoroughly established, and by the time public sentiment is sufficiently aroused to authorize the necessary legislation and bring about united action for public protection it is too late for such action to be of service. Obviously, then, every effort should be made by all State and other officials having such matters in charge to acquaint every citizen with the prominent symptoms of the bark disease and to familiarize him with the fact that unless prompt and united action is taken there is every indication that the chestnut tree in the States above mentioned will become practically extinct within 10 years.

COOPERATION OF THE DEPARTMENT OF AGRICULTURE.

In this campaign of education the Department of Agriculture will cooperate in the following ways: *Copies of this bulletin or of other publications of this Department relating to the bark disease, and also typical specimens of the disease, will be sent to any person applying for them.* Two specimens will be sent to each person—one showing the appearance of the disease on smooth bark, and the other the later development of the fungus on thick bark. In both these specimens the fungus will have been killed by soaking in formalin, to insure against any infection from this source.

So far as the supply permits, lantern slides and photographs will, upon application, be loaned for special lectures, exhibits, etc., to the officers of States, experiment stations, colleges, and schools where agriculture is taught, as well as to tree wardens and other officials whose work may bear directly upon local campaigns of publicity.

This Department will always examine any suspected specimens of this disease sent to Washington by mail, and will report the findings as promptly as possible. Before sending specimens, however, all persons are urged to read the paragraphs on symptoms on pages 6 to 9 in order to select the specimens intelligently. For example, if the end of a girdled and withered branch is sent, it is not possible to make a dependable diagnosis unless a portion of the girdling area happens to be included. This is the only part where the fungus is surely present, and the fungus itself must be seen in order to be absolutely sure of the disease. Portions of the bark that show the small orange or reddish-brown pustules, about the size of the head of a pin, should

always be sent, if these can be found. These commonly occur near the lower edge of the girdling area.

PUBLIC COOPERATION.

With many people familiarized with the appearance of the chestnut bark disease and its possibilities of harm, the disease will be noticed and stamped out by private effort in many places when it first appears and the public will understand and be ready to cooperate in any official measures of control as soon as these become necessary in any locality.

All possible forces must be enlisted in a campaign of publicity. The cooperation of all newspapers, particularly local papers, can be easily secured in all the States where the chestnut is an important tree. A portion of the program for Arbor Day, 1912, should be devoted to a consideration of this disease. Teachers of nature study, botany, or agriculture in the public schools can do great service by teaching their pupils how to recognize the disease and by training them to be on the lookout for its first appearance in the home community. Such a body as the "Boy Scouts" can, if properly trained, become in every community a most efficient force for locating the disease. The boys will readily appreciate that such work is real "scouting" against a most insidious and destructive public enemy. And, finally, many private owners of chestnut trees will be eager to cooperate with the State authorities in the early elimination of advance infections if only they are able to recognize such infections.

THE PROTECTION OF THE SOUTHERN STATES.

It must be remembered that the bark disease has as yet done only a small fraction of the damage that it is undoubtedly capable of doing. The best chestnut timber of America is south of the Potomac River and there the bark disease is present in only a few spots. For this reason it is of extraordinary importance that these few spots be eradicated and that the disease be soon controlled immediately north of the Potomac. If the bark disease once becomes well established in the chestnut forests of the South, it will be well-nigh impossible to control it, on account of the sparsely settled and mountainous condition of much of that country and for other reasons which do not obtain farther north.

SUMMARY.

(1) The chestnut bark disease was first noted near New York City in 1904 and is now present in at least 10 States. It attacks the American chestnut, the European chestnut, the chinquapin, and, rarely, the Japanese chestnut.

(2) The total financial loss from this disease is now estimated at $25,000,000.

(3) The disease is caused by a fungus, and the entrance of a spore at any point where the bark is broken may cause infection. The

disease spreads primarily in the inner bark and produces characteristic lesions which girdle the tree at the point attacked.

(4) Conspicuous symptoms are the development of bunches of sprouts below the girdling lesions; the half-formed yellowish leaves in the spring on the previously girdled branches; the reddish-brown leaves on branches girdled in summer, and the yellow, orange, or reddish-brown pustules of the fruiting fungus on the bark. It is practically useless to attempt systematic location of the disease from October to April, inclusive.

(5) The spores may be carried considerable distances on chestnut nursery stock, tan bark, and unbarked timber; also by birds, insects, squirrels, etc., which have come in contact with the sticky spore masses. Water quickly dissolves these spore masses and the minute spores are in this way carried along with water, as, for instance, with rain water running down a tree. Borers' tunnels form the most common places of entrance for spores.

(6) The only known practical way of controlling the disease in a forest is to locate and destroy the advance infections as soon as possible after they appear and, if the disease is well established near by, to separate the area of complete infection from the comparatively uninfected area by an immune zone. Advance infections should be located by trained observers and destroyed by cutting and burning. As the disease develops almost entirely in the bark, this must be completely destroyed (burned).

(7) In order to carry out the above methods it is essential that the several States concerned secure necessary legislation and appropriations, following the example of Pennsylvania, as no law exists whereby the Federal Government can undertake such work and cooperation among private owners without State supervision is impracticable.

(8) Chestnut nursery stock should be rigidly inspected for the disease and only perfectly healthy plants passed.

(9) The life of valuable ornamental trees may be greatly prolonged by promptly cutting out all diseased areas and removing all disease-girdled branches and then covering the cuts with tar. Spraying is of no use in stopping the fungus after it has once started growth in the bark.

(10) It is recommended that owners of infected woodland cut down and utilize the diseased chestnut timber as soon as possible.

(11) For the present the planting of chestnuts anywhere east of Ohio is not advised, but there is no apparent reason why chestnut orchards west of Ohio may not be kept free from the disease.

[A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to a Member of Congress or the Secretary of Agriculture.]

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